WATER IN MISSOURI

BY BARBARA HARRIS

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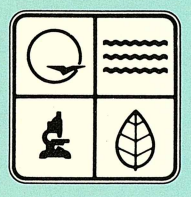

MISSOURI DIVISION OF GEOLOGY AND LAND SURVEY
DEPARTMENT OF NATURAL RESOURCES

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BY BARBARA HARRIS

PREFACE

Water is a geologic phenomenon during its never-ending cycle of travel and, as a geologic phenomenon, it is studied by the Missouri Division of Geology and Land Survey. Since 1921, important cooperative work has been continuously underway between the Division and the U.S. Geological Survey. In addition, many Missouri drillers have been contributing information to the Missouri Division of Geology and Land Survey for years. The result is a large water data base that is invaluable in managing and developing water supplies.

Among those involved in water studies and data collection are Dale Fuller, Robert Knight, and Don Miller of the Missouri Division of Geology and Land Survey, and John Skelton of the U.S. Geological Survey. Along with Jerry D. Vineyard, they provided information and background material for this brief account of water in Missouri.

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a Harris, editor; Barbara R. Miller, composer equipment operator; Susan C. Dunn, artist.

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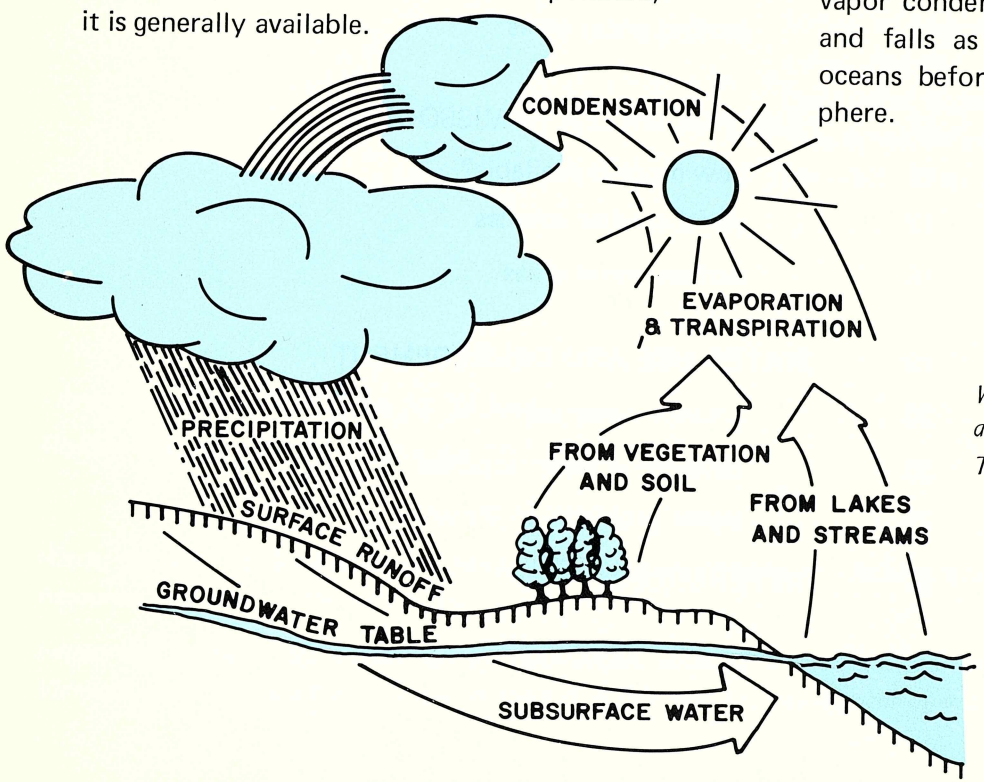
INTRODUCTION

One of Missouri's most important natural resources — essential in every facet of our lives — is water. It is precious because it is used for everything from drinking and cleaning to providing food, energy, and recreation. Yet it is extremely cheap and readily available in many parts of the state. Although water may be fairly expensive in some areas such as north of the Missouri River, in the St. Francois Mountains, or where surface water is polluted, it is generally available.

THE NEVER-ENDING WATER CYCLE

Water moves in a never-ending cycle, circulating between the sky, land, ocean, and back to the sky. This movement, known as the hydrologic cycle is accomplished by the heat of the sun and the pull of gravity. As water evaporates from the wet ground, from plants, and from lakes and reservoirs, it is carried in the air as water vapor, a gas. When the water vapor condenses, it changes back to a liquid and falls as rain to feed lakes, rivers, and oceans before being returned to the atmosphere.



Water circulates between the sky, land, ocean, and back to the sky in a never-ending cycle — THE HYDROLOGIC CYCLE.

HOW MUCH IS AVAILABLE?

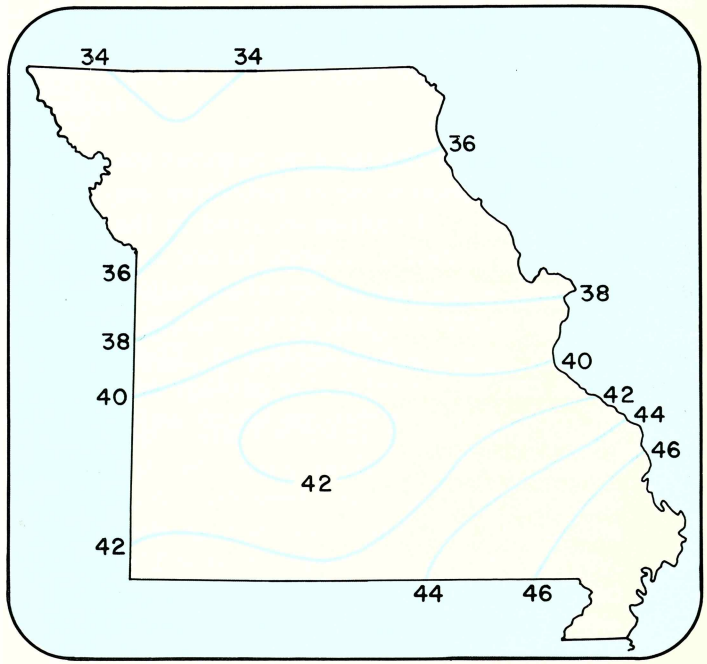
The supply of water seems inexhaustible when one considers that the average annual precipitation of some 30 inches in the United States provides around 4,200 billion gallons of water per day. Of this quantity, about 600 billion gallons per day are available for domestic, industrial, municipal, and agricultural requirements.

The nation's daily water use of 420 billion gallons (excluding hydroelectric power) in 1975 was 75 percent higher than in 1955 while total population increased only 34 percent. Water needs are still rising and, by the year 2000, the demand may be nearly one trillion gallons per day!

Missouri's use of water has paralleled that of the U.S. In 1955, 4.1 million people used 2.3 billion gallons of water each day and 20 years later, in 1975, 4.8 million were using 4.1 billion gallons daily; this trend is continuing. The state has been fortunate in having adequate water supplies to meet these growing needs but Missouri's water, along with its minerals, land, and other natural resources, is limited.

SOURCES OF WATER

When we look at Missouri's lakes, rivers, and streams (surface water), we see only a very small percentage of the state's total water resource. Most of our water is "ground water", meaning that it is found below the earth's surface. Some rain and snow (precipitation) that falls to the ground seeps downward through the soil into aquifers — the porous rock formations that act like sponges and temporarily store water under the ground. Thus, geologists classify water in two broad categories: "surface water" and "ground water".

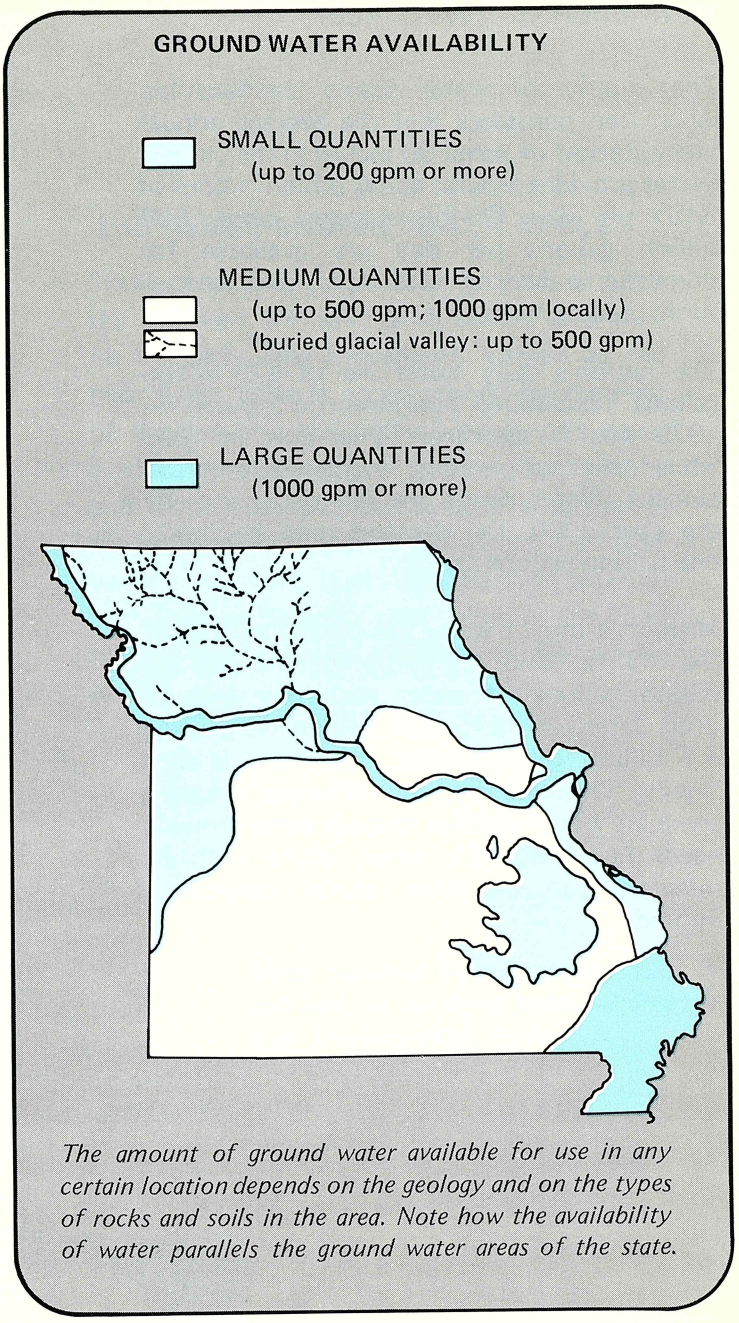


The mean annual precipitation in Missouri ranges from 34 inches in northern Missouri to 46 inches in the Bootheel. (Source: National Weather Service — NOAA)

GROUND WATER IN MISSOURI

Missouri's ground water is present in the pore spaces of sandstones, in joints and fractures of limestones, and between the grains of sand and gravel deposits. It is this water that supplies the state's wells and springs and keeps the rivers and streams flowing during dry periods. It is this water that we rely on for most of our needs . . . that we use in our homes, on our farms, in our industries, and in our cities.

Ground water is not the same throughout the state. North Missouri's water problems are far different from difficulties incurred in the Ozarks or Southeastern Lowlands. In one area abundant fresh water may be found at shallow depths, while in another the water may be in short supply and highly mineralized. These differences can be traced to the geology and types of rocks and soils through which water moves.



The amount of ground water available for use in any certain location depends on the geology and on the types of rocks and soils in the area. Note how the availability of water parallels the ground water areas of the state.

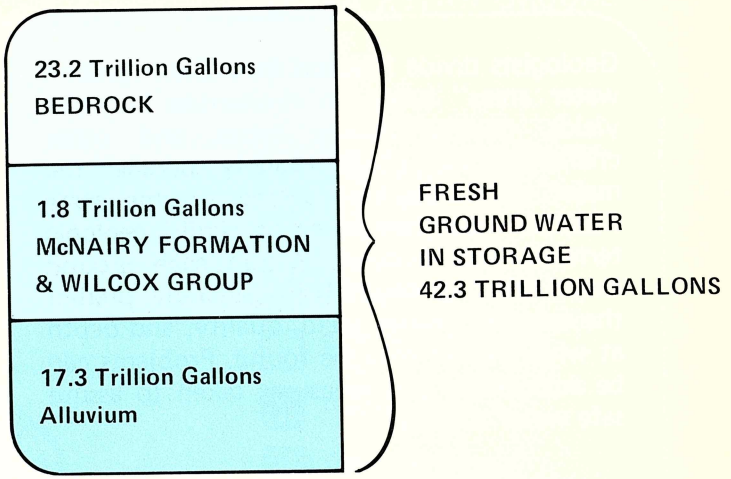
HOW MUCH IS AVAILABLE?

Missouri is fortunate in having large quantities of fresh water beneath two-thirds of its land surface that can be tapped for domestic, industrial, agricultural, and other needs. There is no magic formula for determining exactly how much ground water is available, but the Division of Geology and Land Survey, Missouri Department of Natural Resources, has been studying it for years. Investigations of the state's geology and the water-bearing potential of its rocks have provided much information. Based on continuing research, the Missouri Division of Geology and Land Survey estimates that more than 42.3 trillion gallons of fresh ground water may be stored in the state's aquifers.

In addition to this fresh water, vast amounts of mineralized water lie beneath the surface in northern and western Missouri. A line that geologists call the "fresh water - mineralized water contact zone" goes northeast from Barton County, across the state to Pike County. West and north of this zone the water becomes progressively more mineralized, while east and south of the zone the water is fresh. Unfortunately, mineralized, salty water is virtually useless for many purposes and the cost of treating it to remove the minerals is too high to make it a practical source of water.

FINDING GOOD GROUND WATER

Even though Missouri has vast quantities of ground water, finding safe adequate supplies may be no easy job. Most areas require continuous study because of the complexity of problems that develop in water supply and the rapidly changing water usages.



Of the 42.3 trillion gallons of fresh water believed to be stored in Missouri's aquifers, an estimated 17.3 trillion gallons are in alluvium, 1.8 trillion are in the McNairy Formation and Wilcox Group, and 23.2 trillion are in bedrock.

The best tools for finding water are knowledge of an area's geology and hydrology plus up-to-date well log and other geologic data such as that available in the files of the Missouri Division of Geology and Land Survey. Included are thousands of rock samples and 28,000 logs of wells drilled in all parts of the state. By studying this information, geologists can generally locate good water supplies and help develop practical water use and conservation plans.

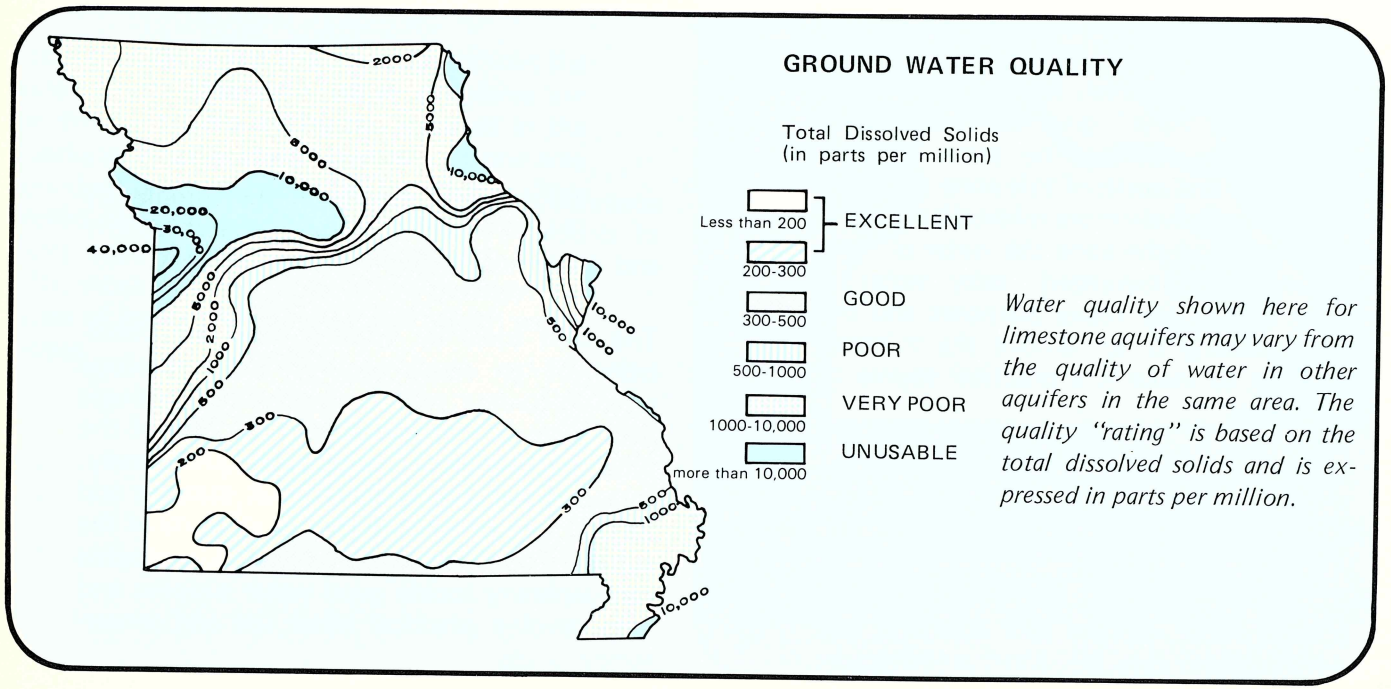
GROUND WATER AREAS

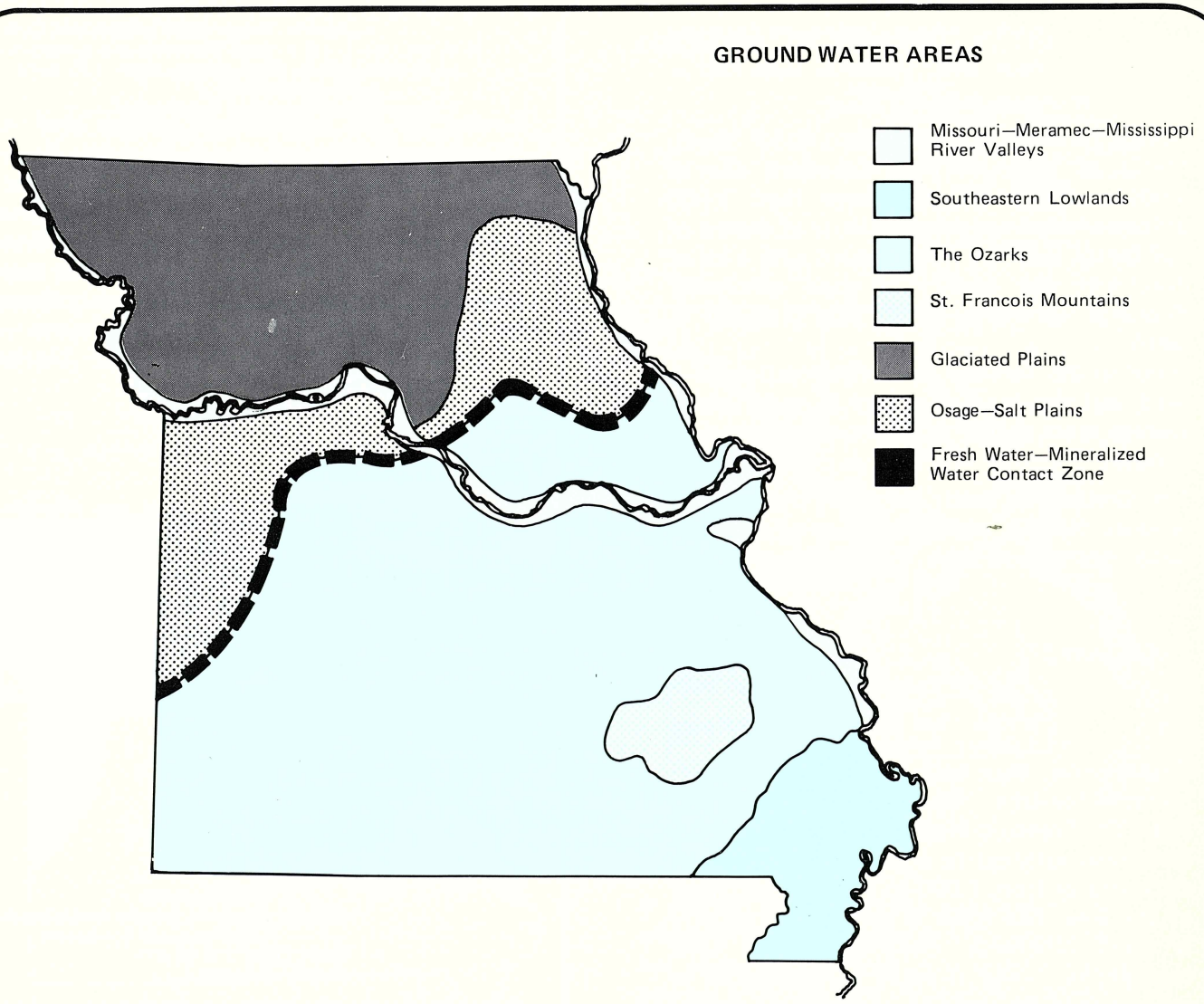
Geologists divide Missouri into seven "ground water areas" based on similarities in water yields, quality, aquifer types, and other characteristics. These roughly parallel the major physiographic regions of the state which, in turn, are based on similar geologic terranes and features. Within each ground water area, geologists can generally predict the expected water yield, quality, and depth at which water may be found. Problems can be anticipated and measures taken to assure safe water supplies.

MISSOURI-MERAMEC-MISSISSIPPI RIVER VALLEYS

Aquifer: River Valley Sands
Water Yield: Variable (0 to 2,000+ gpm)
Quality: Treatment Needed

Includes areas along the Missouri, Meramec, and Mississippi Rivers and smaller streams. The water table is near the surface. Large volumes of fresh water can be pumped rapidly from shallow wells. Extensive treatment is required because the water is hard and has a lot of iron. The quality is good otherwise and supplies are virtually unlimited. Rapid recharge from the rivers gives assurance that water will not be depleted.





Ground water varies throughout the state because of the geology and types of rock and soil through which it moves. Based on similarities in water yields, quality, and other characteristics, geologists have divided Missouri into the seven "ground water areas" shown here.

SOUTHEASTERN LOWLANDS

Aquifer: Alluvial, Tertiary and Cretaceous Sands
Water Yield: Medium to Large (250 to 3000+ gpm)
Quality: Fair to Good

Covers the extreme southeastern tip (or "Boot-heel") of Missouri. River-deposited alluvial sands and gravels yield more than 3,000 gallons of fresh water per minute at depths of 100 feet or less. The water is hard with a lot of iron, but the quality is good otherwise. Recharge (primarily from precipitation) is rapid.

Water in the Tertiary sands (Wilcox Group) is hard, but the general quality is good; yields average more than 2,000 gallons of water per minute.

The Cretaceous sands (McNairy Formation) produce from 0 to 500+ gallons of very soft water per minute; the iron content is low.

THE OZARKS

Aquifer: Ordovician and Cambrian Dolomites and Sandstones
Water Yield: Variable (15 to 1,000 gpm)
Quality: Good

Covers more than half of southern Missouri (except for the "Southeastern Lowlands" and "St. Francois Mountains" areas). Abundant fresh water can be obtained from bedrock at depths of from 1,000 to 1,500 feet in most of the area. The water is hard but its quality is good otherwise. Because of the karst topography, water is easily contaminated so wells should be cased to considerable depth. The aquifer is directly recharged by precipitation except where rocks of Pennsylvanian age (mainly shale) are at the surface. Where these rocks block vertical water movement, recharge is by lateral movement and is much slower.

ST. FRANCOIS MOUNTAINS

Aquifer: Precambrian Igneous and Cambrian Dolomites and Sandstones
Water Yield: Small (0 to 125 gpm)
Quality: Good

Covers the St. Francois Mountains area in southeastern Missouri. Yields from the Cambrian dolomites and sandstones vary from 0 to 125 gallons per minute. Those from the Precambrian igneous rocks average from 0 to 2 or 3 gallons per minute, which is not adequate for most purposes; commonly there isn't enough water for domestic use.

GLACIATED PLAINS

Aquifer: Glacial Drift and Alluvium
Water Yield: 0 to 1,000 gpm
Quality: Marginal

Covers much of northern Missouri. Most of the available water in bedrock is mineralized and yields are small. Useable water is found in the glacial drift and alluvium of streams. The amount of water available should be determined by test drilling.

OSAGE – SALT PLAINS

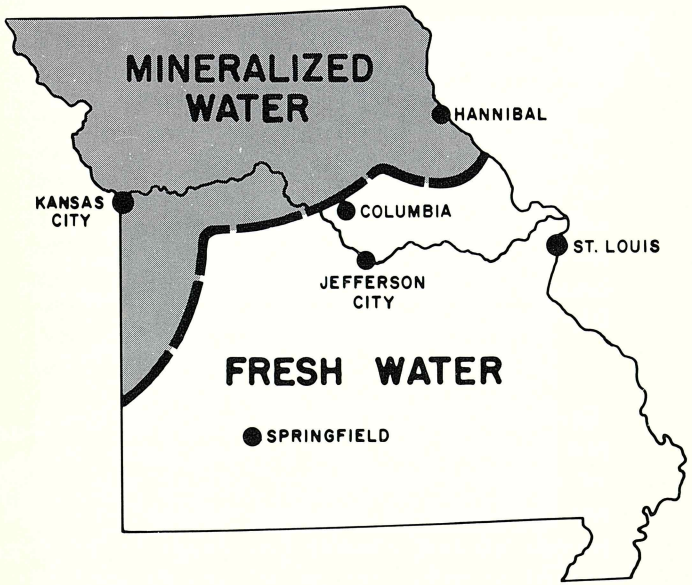
Aquifer: Pennsylvanian and Mississippian Limestones and Sandstones
Water Yield: 1 to 15 gpm
Quality: Marginal

Extends diagonally from southwest-central to northeast-central Missouri. Highly mineralized water is encountered if wells are 400 to 500 feet deep; small yields of fresh water may be obtained from shallower wells in some locations.

FRESHWATER – MINERALIZED WATER CONTACT ZONE

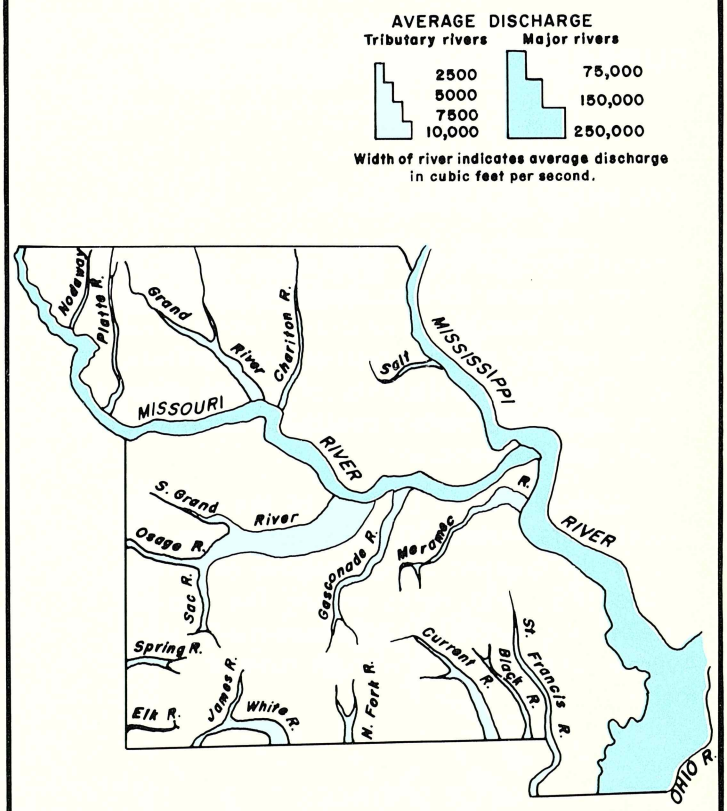
Aquifer: Ordovician and Cambrian Dolomites and Sandstones
Water Yield: Upwards to 1,000+ gpm
Quality: Fresh to Marginal

An intermediate area or line that divides the fresh water areas of southeastern Missouri from the mineralized water areas of northwestern Missouri. This zone runs from Barton County northeast across the state through Pike County. Heavy pumpage near this zone could use up readily available fresh water and mix it with mineralized, salty water from the deep aquifers.



A line (or area) known as the "fresh water – mineralized water contact zone" crosses the state from Barton County, extending northeast through Pike County. West and north of this line, water becomes progressively more mineralized while water east and south of the line is fresh.

DISCHARGE OF PRINCIPAL RIVERS



In addition to the enormous quantities of water available from the Mississippi and Missouri Rivers – two of the nation's largest river systems – large amounts of surface water are available in hundreds of other rivers and streams throughout the state.

SURFACE WATER IN MISSOURI

HOW MUCH IS AVAILABLE?

Missouri has adequate supplies of water in its rivers, streams, springs, reservoirs, lakes and ponds for energy generation, recreational needs, and for most industrial and domestic uses. This ready availability of surface water helps assure the state's continued economic growth and development.

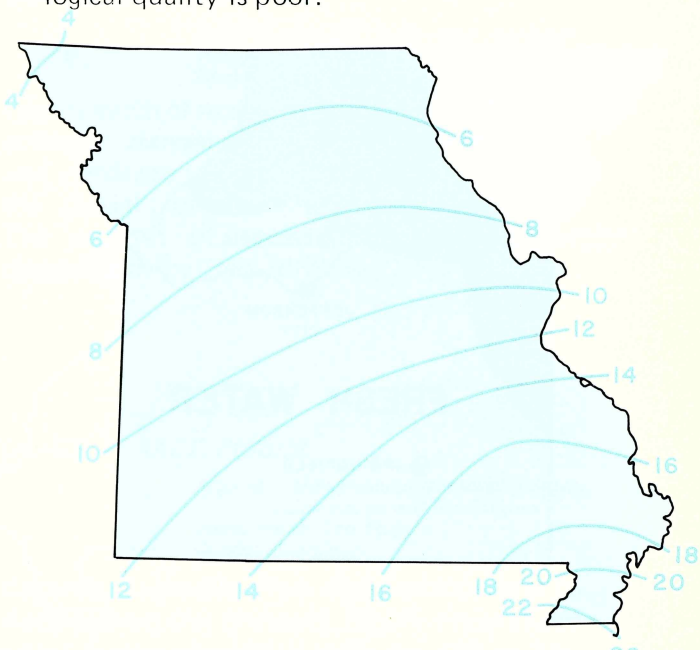
The state is drained by two of the nation's largest rivers, boasts 20,000 stream miles, has one of the greatest concentrations of springs in the U.S., and ranks among the top 10 states in the number of large man-made lakes. Average annual runoff ranges from 4 to 22 inches.

SURFACE WATER SOURCES

RIVERS AND STREAMS

No. Major Rivers: 20 (excl. Miss. & Mo. Rivers)
No. Streams: Numerous
Stream Miles: 20,000
Water Quality: Good; Some Pollution

All of Missouri is drained either directly or indirectly by the Mississippi or Missouri Rivers – two of the largest river systems in the U.S. Together they form the longest waterway in the world, stretching from the Montana Rockies to the Gulf of Mexico. These rivers have significantly influenced the state's history and development and their waters are increasingly important today. The waters are generally of good to fair chemical quality and are suitable for most uses. Some treatment such as softening may be needed for municipal and some industrial uses, or where bacteriological quality is poor.



Average annual runoff, which ranges from 4 to 22 inches in Missouri, is a valuable addition to the state's surface water resources.

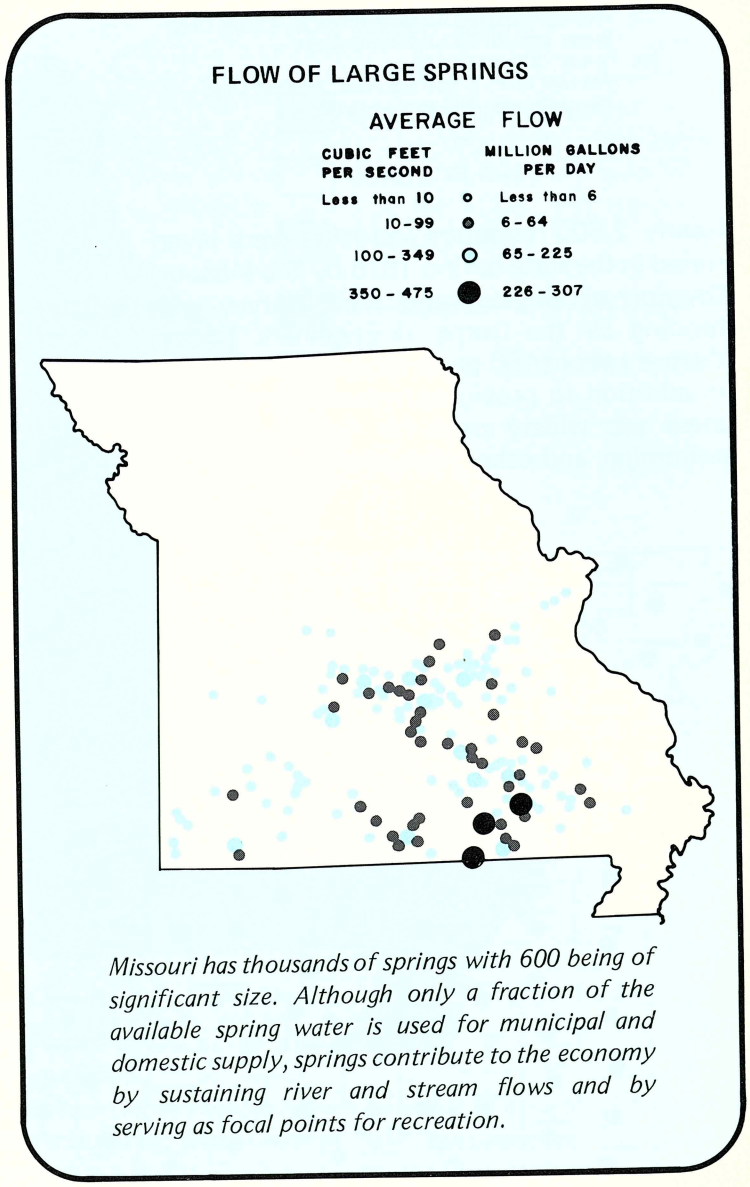
In addition to the Mississippi and Missouri Rivers and their numerous tributaries, the state has access to the ample surface water supplies found in the Meramec, St. Francis, White, James, North Fork, Black, Current, Eleven Point, Spring, Grand, Osage, and Gasconade Rivers.

SPRINGS

No. Springs: Thousands
Water Available: 2,000,000,000+ Gallons Per Day
Water Quality: Good

Missouri has 600 springs of significant size and literally thousands of smaller ones. Their yields range from a few gallons of water per day to amounts capable of supplying the needs of a large metropolitan area. One of the largest concentrations of springs in the U.S. is found in the Missouri Ozarks. Of the nation's 69 first-magnitude springs (flows averaging 100 cubic feet of water per second [64.6 million gallons per day], or more), 10 are in this region.

Although only a fraction of Missouri's available spring water is used for municipal and domestic supply, springs do contribute indirectly to the economy by sustaining the flows of rivers and streams and by serving as focal points for an expanding recreation industry. Many larger springs are being preserved in their natural state by government agencies and individuals, while others are used for watering livestock and raising fish.



Missouri has thousands of springs with 600 being of significant size. Although only a fraction of the available spring water is used for municipal and domestic supply, springs contribute to the economy by sustaining river and stream flows and by serving as focal points for recreation.

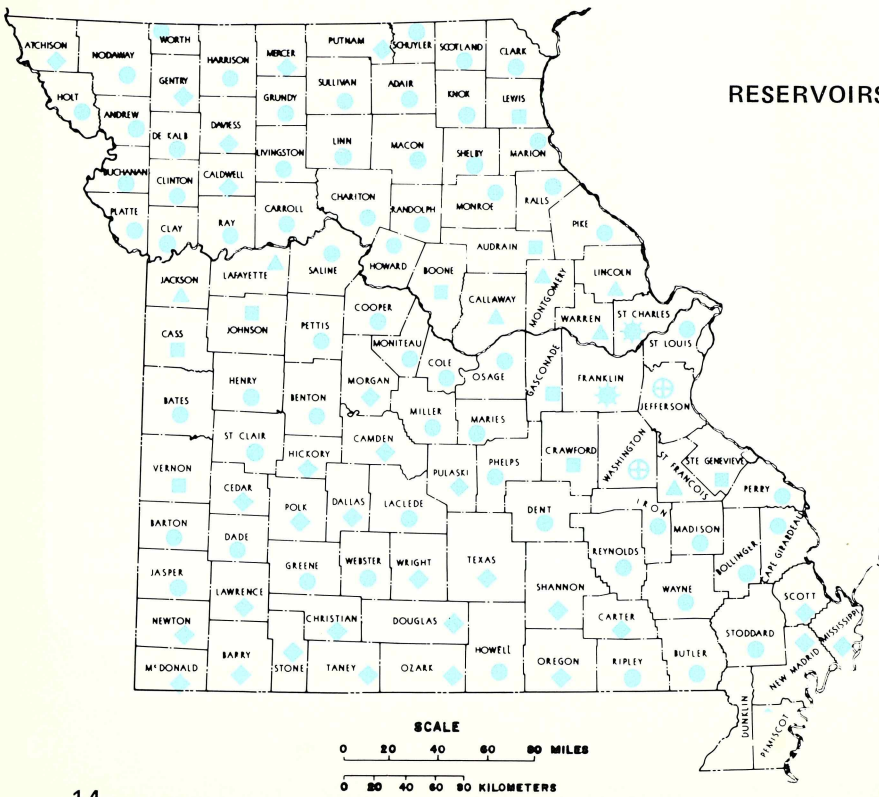
RESERVOIRS, LAKES, AND PONDS

No. Reservoirs: 150
Average Size: 125 Surface Acres, 45 Feet Deep
Water Stored: 110 Billion Gallons
No. Lakes: 2,850
Average Size: 20 Surface Acres, 31¼ Feet Deep
Water Stored: 232 Billion Gallons
No. Ponds: 300,000 Or More
Average Size: ½ Surface Acre, 15 Feet Deep
Water Stored: 293 Billion Gallons

Nearly 2,500 reservoirs and lakes were inventoried in the state during 1975 by the Missouri Division of Geology and Land Survey with funding by the Corps of Engineers. Today, there are about 150 reservoirs and 2,850 lakes. In addition to providing hydroelectric power, these are widely used for fishing, boating, swimming, and other recreation.

In addition to these large bodies of surface water, no one knows exactly how many small lakes and farm ponds dot the landscape, but estimates go as high as 300,000 or more.

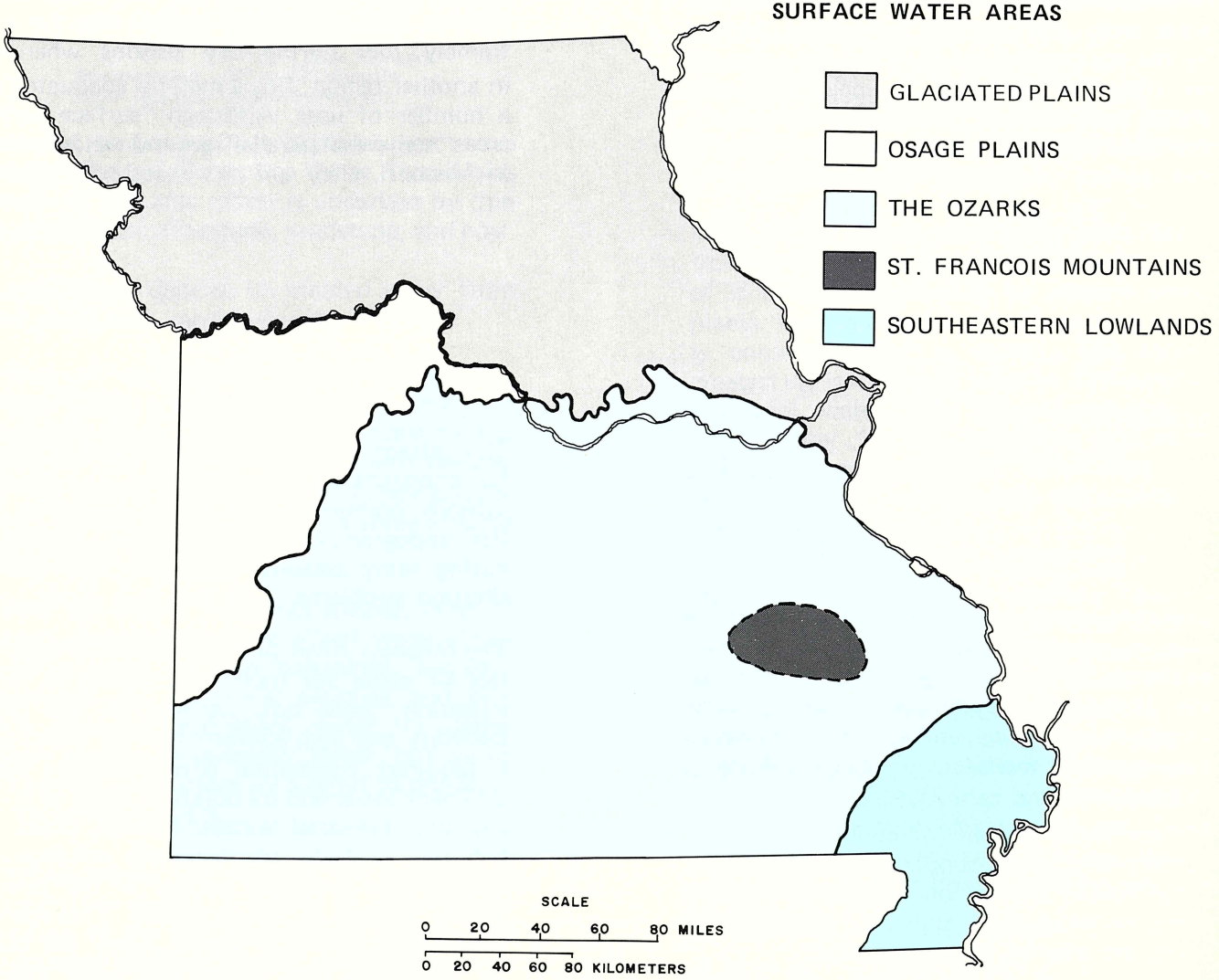
There are far more impoundments in northern Missouri than in southern Missouri, simply because the need is greater and soil conditions are more favorable. Not only do these provide water during dry seasons for livestock, irrigation, and other uses, but they also offer fishing, swimming, and winter skating opportunities. Many farm ponds depend entirely on surface runoff from rainfall and, when strategically located, may be relied on to tide crops over during short, dry spells.



RESERVOIRS AND LAKES IN MISSOURI

NUMBER OF LAKES AND RESERVOIRS
- 0 — 10
- 10 — 30
- 31 — 50
- 51 — 70
- 71 — 90
- 91 — 110

The 2,500 reservoirs and lakes inventoried by the Missouri Division of Geology and Land Survey in 1975 contained 272,273 surface acres of water. Today there are some 3,000 reservoirs and lakes with dams, 25 feet or more high, or storing at least 50 acre feet of water, that impound 342 billion gallons of water.



Missouri has five distinct areas with characteristic landscapes formed by action of natural processes on rocks of differing geologic character. Within each of these "physiographic regions", the quantity, quality, and characteristics of the surface water are quite similar.

SURFACE WATER AREAS

Missouri can be divided into five distinct areas with characteristic landscapes formed by the sculpturing action of natural processes on rocks of differing geologic character. Within each of these "physiographic regions", the quantity, quality, and characteristics of the surface water are quite similar. For example, water flowing in the rivers and streams of a particular region may be extremely low during dry seasons whereas, in another region, flows may be adequate for a number of uses. Although "surface water areas" somewhat parallel" ground water areas" in Missouri, they are not exactly the same.

GLACIATED PLAINS

Water Sources: Runoff — 5" to 8" Annually
Rivers, Streams — Low Base Flow
Springs — Few
Lakes — 951
Ponds — Many
Precipitation: 34" to 36" Annually
Water Quality: Treatment Needed

Covers much of northern Missouri. Most of the area is underlain by clayey subsoils with moderate to very low permeabilities. Most of the bedrock is shale, but there is some limestone, sandstone, and coal in places which may result in moderate to severe leakage in impoundments.

Surface water is used for cooling by electric power plants, public supplies, and related uses. Large towns depend on treated water from rivers or lakes; rural, domestic surface-water needs are met by lakes or ponds.

Reservoirs are often used to store drainage from small areas because ground water supplies are difficult to develop and some supplies are not adequate during extended dry spells.

The terrane and soils are generally suitable for constructing impoundments. The clayey subsoils, combined with the gently rolling to flat topography, cause drainage problems during rainy seasons. Soils may also create siltation problems.

The Missouri River provides adequate quantities of water for municipal, industrial, and irrigation needs but, because of the high turbidity and high coliform counts, treatment is required. Recreation is restricted by high sediment loads and by pollution from municipal and industrial wastes. Natural flows of tributary streams are generally inadequate during mild droughts except in the downstream reaches of the Nodaway, Thompson, Grand, and Chariton Rivers. They are used for recreation even though the water moves slowly and is silty. Crops or distribution systems might be damaged if the highly sedimented water is used for extensive irrigation.

OSAGE PLAINS

Water Sources:	Runoff — 8" Annually
	Rivers, Streams — Low Base Flow
	Springs — Few, Small
	Lakes — 350
	Ponds — Large Numbers
Precipitation:	36" to 40" Annually
Water Quaiity:	Treatment Needed

Located in west-central Missouri, just south of the Missouri River. The Osage River drains much of this area which is underlain by thin layers of shale, limestone, sandstone, and coal.

Large towns depend on treated water from the rivers and impoundments.

Flows of unregulated streams (except the Osage River) are generally inadequate during droughts. Water quality varies. Treatment is required for water in some streams because of high salinity and high bacteriological counts. High bacteriological counts on some streams also restrict recreation.

There are only a few small springs, most of which yield highly mineralized water. They supply water for fish hatcheries, augment municipal and industrial supplies, and provide domestic and stock water for farms. Water quality is generally stable, but spring flows vary. The springs are subject to pollution from surface sources.

Impoundments are needed to supplement streamflow during droughts in some places because of the low base flow of streams and unsuitable aquifers. Lakes generally provide flood control and water supply; some are used for recreation. The area is generally suitable for reservoir construction.

THE OZARKS

Water Sources:	Runoff — 10" to 18" Annually
	Rivers, Streams—High Sustained Flow
	Springs — Common
	Lakes — 971
	Ponds — Numerous
Precipitation:	38" to 46" Annually
Water Quality:	Variable

Covers more than half of southern Missouri (except for the "Bootheel").

Most of the water withdrawn each day is from the Missouri and Mississippi Rivers; much of it is used for cooling by electric power plants. Only a fraction of this cooling water is consumed, but is reused. The second greatest use is for public supplies. Self-supplied industrial water uses consist primarily of spring water for fish hatcheries and water pumped from mines for dewatering ore deposits. Other uses include manufacturing and food processing.

Ozark rivers and streams generally have the highest sustained flows in the state because of abundant groundwater inflow from natural reservoirs in the soluble carbonate rocks. Low flows of the principal streams are generally adequate for dependable supplies but tributary streams need low-flow augmentation. Water quality varies and is subject to contamination from surface sources. Treatment is generally required. Principal streams are widely used for floating, fishing, and fish propagation.

Numerous large springs along principal rivers and streams assure well-sustained base flows. Several supply water for fish hatcheries and aquatic plant developments, and are used for recreation and as park attractions.

Impoundments supplement streamflow during droughts. Certain hydrologic and geologic conditions in the karst topography, however, make Ozark lakes and ponds susceptible to failure from leakage.

ST. FRANCOIS MOUNTAINS

Water Sources: Runoff — 12" to 16" Annually
Rivers, Streams — Few
Springs — Very Few
Lakes — Very Few
Ponds — Relatively Few
Precipitation: 40" to 44" Annually
Water Quality: Good

Covers the St. Francois Mountains area in southeastern Missouri. Most igneous rocks here are relatively impermeable.

There are few rivers, springs, or lakes in this area. Lake construction in the upper valleys is hindered by lack of readily available soil for earthen dams.

Missouri's abundant ponds and lakes make life richer by attracting wildlife.

SOUTHEASTERN LOWLANDS

Water Sources: Runoff — 18" to 20" Annually
Rivers, Streams — High Base Flow
Springs — Few, Small
Lakes — 43
Ponds — Relatively Few
Precipitation: 46" Annually
Water Quality: Fair

Covers the extreme southeastern tip (or "Bootheel") of Missouri. Although there are low, rolling hills, most of the area is flat.

This area ranks second to the Ozarks in the amount of available surface water in rivers and streams because of the extensive ground water inflow from the alluvial aquifer underlying the area. Large amounts of water are stored in the alluvium.

During periods of flood, however, water piles up and runs off slowly. Major channels have been constructed to help control flooding and to drain the excellent farmlands. Since these ditches were built, ground water releases from the alluvium have generally been large which partially accounts for the well-sustained surface water flows.

There are only a few small springs.

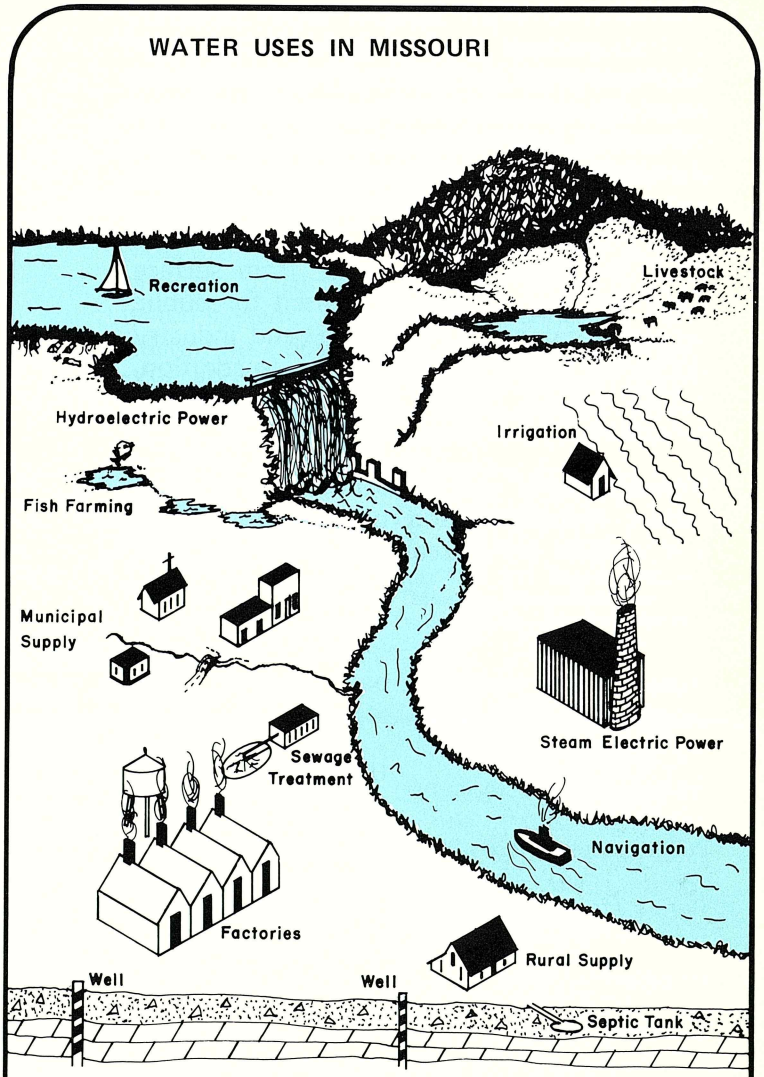
Forty-three lakes were inventoried in this area. In the hilly part to the south (Crowleys Ridge and Benton Hills), there are excellent settings for lakes. Water-loss problems are unlikely because the bedrock is mostly highly-impervious clay, but there may be seepage problems with dams built of the silt-rich soil. In the flat area to the north where soil materials range from permeable sand to impermeable clays, impoundments may have problems caused by water table fluctuations or unstable slopes.

WATER USE AND DEVELOPMENT

Overall, Missouri has moderately large water supplies to use and favorable supply-to-demand relationships.

Although more towns in the state presently depend on ground water than on surface water, larger quantities of surface water are being withdrawn because most of Missouri's large cities rely on surface sources. These include St. Louis, Kansas City, Poplar Bluff, Jefferson City, St. Joseph, Joplin, and Cape Girardeau. Ground water meets the major water needs of Columbia, Independence, and St. Charles.

In many locations bountiful supplies from both ground and surface sources are available, but for economic or other reasons only one or the other is developed. Springfield, Kirkwood, Sedalia, and St. Charles are among the cities that have developed both ground and surface sources and rely on one while the other is held in reserve.

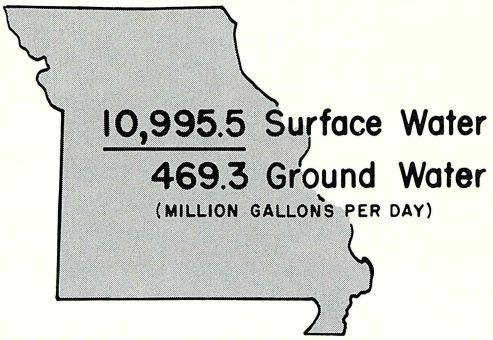


Missouri has moderately large water supplies and a favorable supply-to-demand relationship. Generally, the demand for water for most uses is met by locally available supplies.

PRESENT WATER USE

Approximately 4,164.8 million gallons of water are withdrawn each day for purposes other than hydroelectric power. This is only a small percentage of Missouri's total available water supply. Some 469.3 million gallons come from ground water reservoirs while 3,695.5 million gallons come from surface water sources. This water is used for public supply, rural needs, irrigation, and industry (including thermoelectric power). In addition, 7,300 million gallons are used daily for generating hydroelectric power.

Nonwithdrawal uses of water such as navigation, recreation, and propagation of fish and wildlife are increasingly important also.



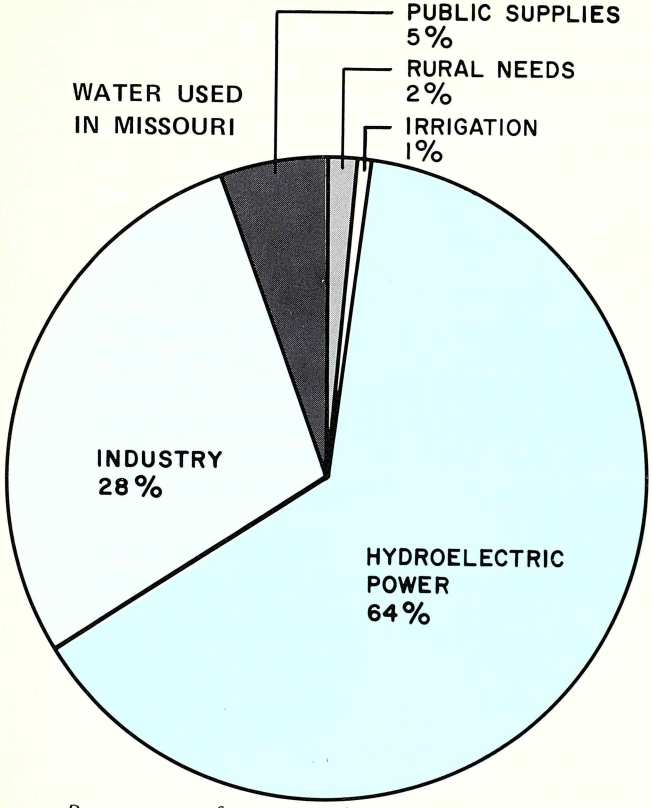
Withdrawals from surface water sources (upper value) and from ground water aquifers (lower value) totaled 11,464.8 million gallons per day during 1975.

WATER USED IN MISSOURI – 1975

(million gallons per day)

USE OF WATER	GROUND WATER	SURFACE WATER	TOTAL WATER
Public Supplies *(industrial, commercial, domestic)*	120.0	490.0	610.0
Rural *(domestic, livestock)*	81.0	130.0	211.0
Irrigation	91.0	5.5	96.5
Self-Supplied Industry *(thermoelectric power for electric utilities and other industrial uses)*	177.3	3,070.0	3,247.3
Total Water Withdrawn *(uses other than hydroelectric power)*	(469.3)	(3,695.5)	(4,164.8)
Hydroelectric Power		7,300.0	7,300.0
Water Used in Missouri in 1975	469.3	10,995.5	11,464.8

Source: USGS Circular 765



Percentages of water used in Missouri during 1975 ranged from 64% of the total for hydroelectric power down to 1% for irrigation.

PUBLIC WATER SUPPLIES

Daily Water Use: 610 Million Gallons
Purpose: Domestic, Commercial, Industrial Needs
Source: Ground Water, River, Streams

Around 60 million gallons of water are used each day for domestic, commercial, and industrial needs in Missouri. This is an average of about 158 gallons per day per capita.

Domestic needs include water used in the home for drinking, cooking, washing clothes and dishes, bathing, toilet flushing, and garden or lawn sprinkling. Public water supply systems also serve commercial and industrial needs with industry being the largest user of public supplies.

Most of this water is not consumed but is returned to surface streams or to the ground water system. These uses are generally considered *nonconsumptive* in contrast to irrigation and fossil fuel burning power plants which are the largest *consumptive* users.

RURAL WATER NEEDS

Daily Water Use: 211 Million Gallons
Purpose: Domestic, Livestock Needs
Source: Wells, Springs, Streams, Ponds

Rural domestic and livestock water needs require an estimated 211 million gallons each day.

Sources for domestic and stock water supplies (excluding irrigation) are wells, springs, streams, and ponds. While a large part of the domestic supply is pumped from wells, much of the water for livestock is obtained from streams and ponds.

IRRIGATION

Daily Water Use: 96.5 Million Gallons
Acres Irrigated: 260,000
Source: Wells Primarily; Also Streams, Impoundments

For years, Missouri depended almost entirely on rainfall to provide moisture for crops,

but recurring drought periods have gradually renewed interest in irrigation. During the 1930's only a few thousand acres of crops were being irrigated; by 1975, Missourians were withdrawing 96.5 million gallons of water each day to irrigate some 260,000 acres of land.

Most of the water for irrigation comes from wells, with streams and impoundments also being used. Irrigated crops include corn, cotton, rice, fruit, vegetables, soybeans, alfalfa, and pasture.

The greatest concentration of irrigation in the state is in the Southeastern Lowlands where the land is flat, the climate is suitable for growing rice, corn and other crops, and large quantities of water are available from alluvial wells at low cost. Along the Missouri and Mississippi Rivers, water for irrigation is obtained from alluvial wells and surface sources. Pasture irrigation is increasing in the dairy and stock raising parts of the state while ground water is pumped for irrigation of truck farms near Kansas City and St. Louis, in Barton County, and elsewhere.

SELF-SUPPLIED INDUSTRIAL USE

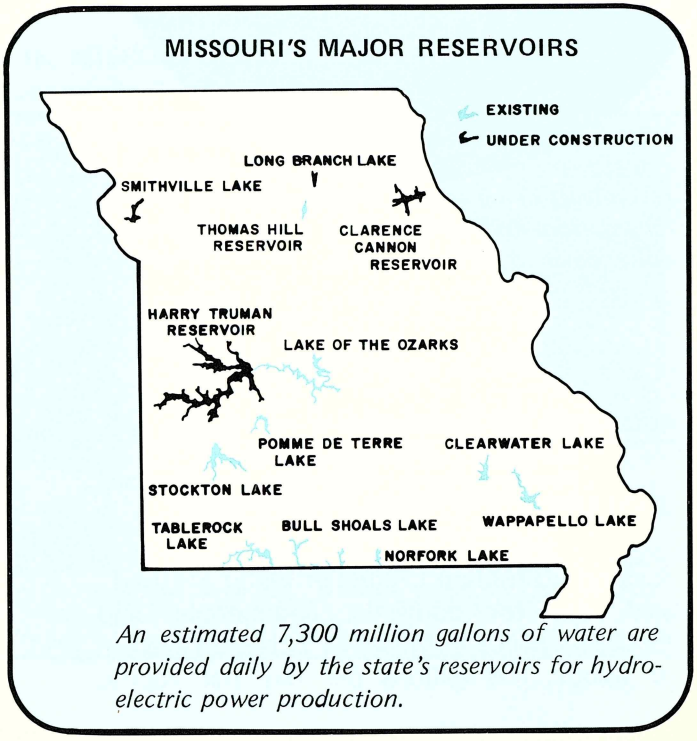
Daily Water Use: 3,247.3 Million Gallons
Purpose: Manufacturing, Mining, Electric Utilities, Construction, Etc.
Source: Rivers, Streams, Impoundments

Much of the 3,247.3 million gallons of water used per day for self-supplied industrial use (including thermoelectric power for electric utilities) is derived from rivers, streams, and impoundments. Nearly 90 percent of the water withdrawn for manufacturing, mining, construction, and other industries is nonconsumptive. In other words, it is returned to water sources for additional use.

HYDROELECTRIC POWER

Daily Water Use: 7,300 Million Gallons
Source: Reservoirs

An estimated 7,300 million gallons of water are used each day for hydroelectric power production. Being nonconsumptive, this use does not affect other uses of the same water, except in the control of reservoirs and the incidental effects that storage may have on water quality.



An estimated 7,300 million gallons of water are provided daily by the state's reservoirs for hydroelectric power production.

DEVELOPING WATER SUPPLIES

Missouri has always been able to meet its water needs but steadily increasing demands make wise management essential. Future shortages and other problems should be anticipated.

In the past, the big problem was how to locate ground water supplies when surface water wasn't available. Now, backed by experience and vast amounts of data, geologists can find water quickly and easily when it's available. The current problem is to manage water resources prudently.

Good management depends on knowledge of basic water facts. Although much information is available, detailed studies of water in local areas are needed along with basic research on replenishment and movement of water. Knowledge is needed about water chemistry, who is using water, how much is used, sources from which water is withdrawn, how much is discharged, etc.

WATER PROBLEMS IN MISSOURI

Missouri's water problems are mostly related to the effects of pollution rather than to broad regional water shortages or to continuously declining ground water levels. Highly mineralized or saline water causes some problems, particularly in northern Missouri.

INADEQUATE WATER SUPPLIES

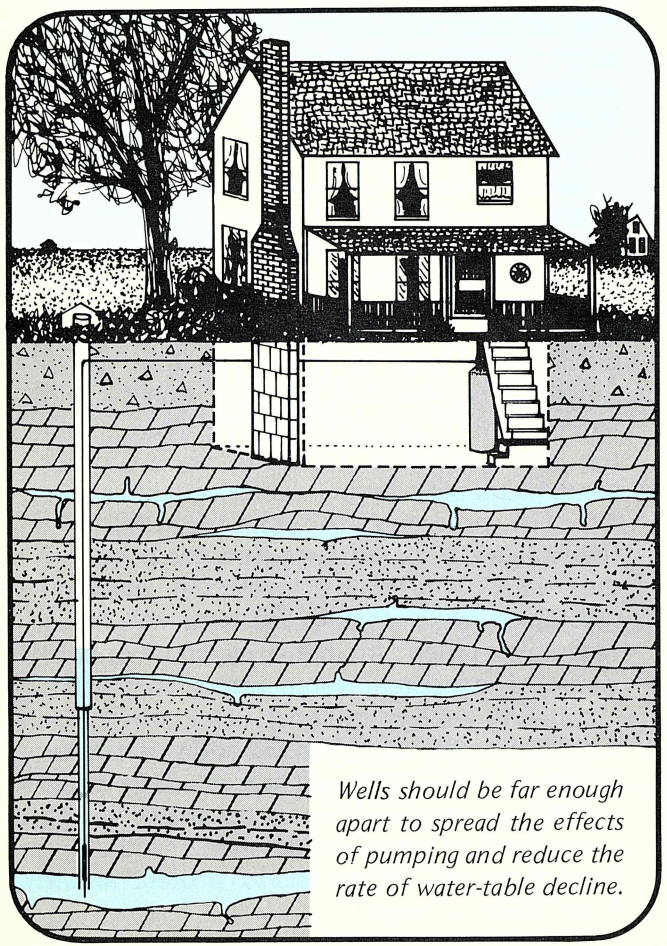
A few problems of inadequate local supplies do exist. Where this occurs, surface and ground water sources should be investigated and the reasons for shortages determined. Surplus surface water might be stored in underground reservoirs for later use or wells might be drilled deeper or in different locations. Municipal, industrial, and irrigation uses might be planned to economize and prevent waste, particularly during dry seasons. The solution will depend on detailed knowledge of basic water facts for that particular area and persons with the expertise to apply that knowledge.

VARYING WATER QUALITIES

The quality of water is as important to many water users as is the quantity. Water for drinking must be of good quality and free of harmful bacteria. It should not contain too many minerals. Industry, on the other hand, requires varying water qualities for different processes. In manufacturing synthetic fabrics, for instance, too much iron in the water will stain fabrics; in canning vegetables, water that is too hard will make vegetables tough; in industrial cooling, cold water of consistent temperature is needed.

Although water of varying qualities normally occurs in certain parts of the state, the water quality in a particular area may change somewhat as a result of man's activities. Provisions can be taken to protect water from these changes.

The quality of ground water doesn't change as dramatically as that of surface water. It is generally more sanitary (even where there is contamination) because bacteria are filtered as ground water passes through soils and rocks. In addition to its bacteriological purity, ground water is preferable to surface water for many purposes because of its constant temperature. Also the more stable chemical content of ground water tends to make treatment easier.



Wells should be far enough apart to spread the effects of pumping and reduce the rate of water-table decline.

DECLINING GROUND WATER LEVELS

A few local areas have experienced declining ground water levels because withdrawals of water have exceeded recharge.

Water levels rise in wet periods and decline in dry periods so that in areas that are not heavily pumped, levels generally average about the same season after season. There are a few areas though where ground water is taken out faster than it is replenished, and the water levels are lowering persistently.

In western Missouri, irrigation is gradually lowering the ground water levels. Major problems have not developed in this state as yet. In other states though, heavy pumping has actually "mined" subsurface waters and corrective measures are not always available. In some other states, for example, underground water conservation districts are promoting conservation measures to increase recharge, to take advantage of storm runoff for irrigation and artificial recharge, and to reduce waste. Minimum well spacing is required to spread the effects of pumping and to reduce the rate of water-table decline.

Problems of declining water levels can be alleviated by artificially recharging water into the aquifer through seepage pits or wells; by inducing recharge from nearby streams; or by developing supplies from more remote sources. Many U.S. problem areas do not have water for recharge.

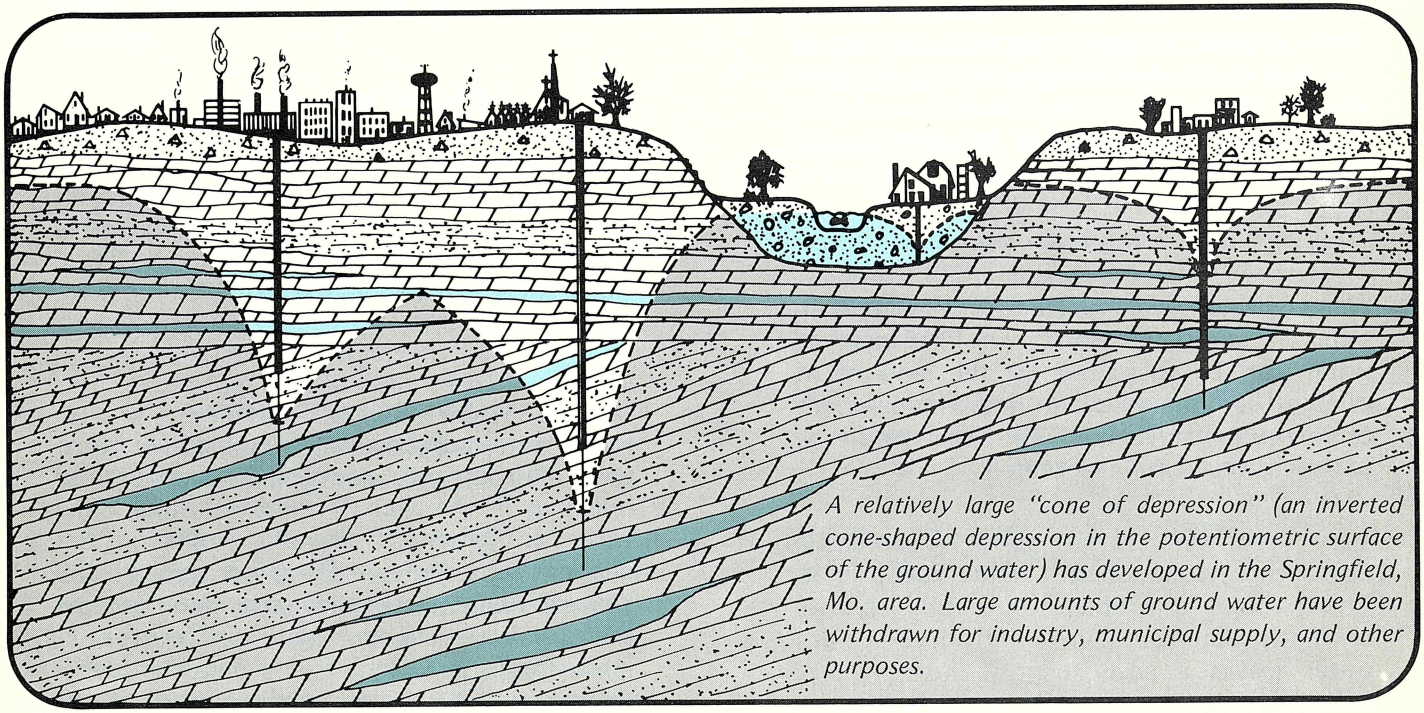
Heavy pumping of water from a well may lower the water table around the well and

create a *cone of depression.* Around small-yield wells in productive aquifers, the cone of depression is quite small and shallow. Wells pumped for irrigation or industry, however, may withdraw so much water that the water table is lowered considerably and the cone of depression may extend for miles.

Recent hydrologic studies by the Missouri Division of Geology and Land Survey in cooperation with the U.S. Geological Survey show a relatively large "cone of depression" in the Springfield area where large amounts of water have been withdrawn for industry, municipal supply, etc. When heavily-pumped wells are too close together and water levels get too low, then supplies may be limited and costs greatly increased.

EXCESSIVELY MINERALIZED OR SALINE WATER

Water is a solvent. From the time rain falls to the ground and begins to pass through soils and rocks, it dissolves the rocks and picks up minerals. Ground water usually has more dissolved minerals than surface water because it is in contact with soils and rocks longer. These dissolved minerals are called *salts* and commonly include sodium, calcium, magnesium, potassium, etc. If these exceed 1,000 parts per million (i.e., if there are more than 1,000 pounds of salt for each million pounds of water), the water is called *saline.* In high concentrations, certain saline water can cause trouble. Too much sodium chloride (table salt) in the water can be harmful to people with heart trouble. Boron is good for some



A relatively large "cone of depression" (an inverted cone-shaped depression in the potentiometric surface of the ground water) has developed in the Springfield, Mo. area. Large amounts of ground water have been withdrawn for industry, municipal supply, and other purposes.

plants in small amounts, but only slightly larger quantities may be toxic.

Water with more than 500 ppm of dissolved solids is not considered desirable for domestic supplies, but more highly mineralized water is commonly used because better water is not available, particularly in northern Missouri.

The process of desalination of brackish water is being refined and improved, and may be economically feasible.

ALKALINE OR ACID WATER

The balance between alkalies and acids in water (known as pH) is another quality to be considered. A pH of 7 indicates neutral water; above 7, the water is alkaline and below 7, it is acid. Alkaline water tends to form scale while acid water corrodes. Good water should be nearly neutral — neither too alkaline nor too acid.

HARD WATER

Water with a lot of calcium and magnesium salts is considered *hard.* The hardness of water can be measured by the amount of calcium carbonate (the principal constituent of limestone) or its equivalent that would be formed if the water evaporated.

Very hard water is not good for domestic use because soap doesn't lather easily in it. This is less a problem now than before synthetic detergents were introduced. Hard water leaves a scaly deposit inside pipes, boilers, and tanks, reducing its suitability

HARDNESS OF WATER
(calcium carbonate content)

Parts Per Million	Type of Water
0 - 60	Soft
61 - 120	Moderately Hard
121 - 180	Hard
Over 180	Very Hard

for home and some industrial uses. Hard water can be made soft at fairly reasonable cost, but really soft water is likely to corrode machines and boilers and is suitable for laundering, dishwashing, bathing, and other uses.

EXCESSIVE IRON IN WATER

Ground water frequently has too much iron, particularly when the water is a little on the acid side. It can cause reddish stains on fixtures and clothing. Like hardness, excessive iron can be reduced easily; in fact, some home water softeners also remove iron.

SALT WATER ENCROACHMENT

Fresh water supplies can be ruined by saline water moving into aquifers through natural openings in the rock formations. Since fresh water is lighter, it literally floats on the heavier salty water. Pumping upsets the delicate balance between the two, causing the salt water to mix with or "encroach" upon the fresh water. If pumping is reduced, the excess salts may eventually be flushed out

by fresh water recharging the aquifer, but it may take many, many years for flushing to be complete. When salt encroachment is too severe, the reservoir may be spoiled for future use.

A critical region in Missouri is the Fresh Water - Mineralized Water Contact Zone where salt water encroachment is an ever-present danger. Large municipal and irrigation wells should be as far as possible from this boundary between the state's saline and fresh water supplies.

At Warrensburg, in Johnson County, wells on the west side of town have salty water and those on the east side have fresh water. Over-pumping here will cause encroachment of salty water, permitting it to mix with fresh water supplies.

POLLUTED WATER

Not only must water for drinking not contain too many mineral salts, but it must also be free of harmful bacteria. Disposal of wastes directly into ground and surface water supplies can make them unusable. When surface water is polluted by mine water, sewage, flood water, industrial waste or other pollutants, ground water can be adversely affected.

Certain industrial wastes are particularly troublesome and can ruin water when dumped into rivers or streams or when buried in the ground. Chemical fertilizers and pesticides can contaminate water supplies either by direct contact, drainage, irrigation return flow, etc. If detergent-bearing water is discharged directly into streams or seeps from septic tanks into the aquifer, it too poses a threat to water quality.

Fortunately, community action and legislation have restricted improper disposal practices. Modern water treatment plants reduce bacterial counts, improve taste and odor, and can even clean out sewage wastes so that treated water is perfectly safe to drink.

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WATER PROBLEMS OR QUESTIONS?

contact the following for assistance . . .

INFORMATION NEEDED	AGENCY	ADDRESS
Locating and developing water supplies; water quality in home wells; ground water and surface water data; sites for lakes, lagoons, septic tanks, etc.	Division of Geology & Land Survey	Box 250, Rolla, MO 65401
Regulations on water quality, solid waste disposal, and pollution control; water supplies, use, and conservation.	Division of Environmental Quality	Box 1368 Jefferson City, MO 65101
Safe water criteria; bacteriological and chemical analyses of water.	Division of Health	Box 570 Jefferson City, MO 65101
Surface water data.	USGS Water Resources Division	1400 Independence Rolla, MO 65401

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